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Earth System Dynamics
Discussions

Interactive comment on "The Fractional Energy Balance Equation for Climate projections through 2100" *by* Roman Procyk et al.

Anonymous Referee #3

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The authors apply a fractional energy balance equation to model temperature variations. They formulate the model in a Bayesian framework. This approach is used to perform temperature projections, and estimate the equilibrium climate sensitivity and the transient climate response. These are compared with the CMIP5 and CMIP6 projections. The paper is mostly well written and the topic fits the scope of the journal. I find the paper worthy of publication in ESD. However, I would recommend some major revisions before the paper is ready to be published.

The manuscript provides, at times, incomplete details on how the results were obtained and how the approach was designed, making reproducibility of the results difficult. I would suggest sufficient details be added. This would also help make potential errors in the approach more detectable.

I would also like to see some discussion on approximating the joint prior probability density functions with a multivariate Gaussian process, including what motivated this decision, how accurate this approximation is and if this could have any repercussions for the final results. How the covariance between the parameters used in the joint prior distribution is determined should also be included.

Other than this I have some minor comments and suggestions:

- Physical units and chemical formulas should not be typeset in italics.
- Ranges should be denoted using en dashes (–), instead of hyphens (-), e.g. 1998–2015.
- Top panel in figure 6: The horizontal axis of the smaller window ranges from 0 to 25 years, but the dotted lines suggest it is taken from the range of 0 to 50 years from the larger figure. Please correct/clarify.
- Line 274: The likelihood function is said to be a posterior probability. This is incorrect, as the likelihood is a distinct probability distribution. Also in line 274: the terms "posterior" and "a priori" seem to have been switched.
- Being in the Bayesian modeling framework, where parameters are treated as stochastic variables instead of fixed and true values, I think it would be more appropriate to use the term "credible intervals" instead of "confidence intervals". The former refers to an interval within which an unobserved (stochastic) parameter value falls with a particular probability, whilst the latter is an interval that we are, to a certain degree, confident include the true (deterministic) parameter value.

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